

1. An optical waveguide apparatus comprising:

a waveguide capable of propagating light in two-dimensional directions;

5 a light transmitting unit for transmitting light through said waveguide;

a light receiving unit for receiving light transmitted through said waveguide; and

relaying means for relaying light transmitted from said light transmitting unit and propagating in said waveguide at a place between  
10 said light transmitting unit and said light receiving unit to transmit the relayed light to said light receiving unit.

2. The optical waveguide apparatus according to claim 1, wherein said relaying means is constructed such that a propagation condition of  
15 light propagating in said waveguide can be changed at a place on a light propagation path between said light transmitting unit and said light receiving unit in a relaying manner.

3. The optical waveguide apparatus according to claim 1, wherein  
20 said relaying means includes a structure capable of diffusing a light beam propagating in the form of a beam toward 360-degree all directions, or toward directions of a predetermined angular range in said waveguide.

4. The optical waveguide apparatus according to claim 3, wherein  
25 said structure has a thickness less than a thickness of a core layer of said waveguide.

5. The optical waveguide apparatus according to claim 1, wherein

said relaying means includes a reflective structure capable of changing a propagation direction of a light beam propagating in the form of a beam with maintaining the beam form.

5           6. The optical waveguide apparatus according to claim 3, wherein a waveguide capable of transmitting light is vertically formed to said waveguide capable of transmitting light in two-dimensional directions.

10           7. The optical waveguide apparatus according to claim 1, wherein said relaying means includes a structure capable of changing a propagation condition of light propagating in said waveguide without processing light in a regenerative manner by amplification and shaping.

15           8. The optical waveguide apparatus according to claim 1, wherein said relaying means includes a light receiving device for receiving the propagating light to convert an optical signal of the propagating light into an electrical signal, and a light emitting device for reconvert the electrical signal obtained by the signal conversion into another optical signal such that a propagation condition of light propagating in said waveguide can be  
20 changed by processing the propagating light in a regenerative manner by amplification and shaping.

25           9. The optical waveguide apparatus according to claim 1, wherein said waveguide has a structure in which a sheet-shaped core layer sandwiched by a first cladding layer and a second cladding layer.

10. The optical waveguide apparatus according to claim 1, wherein

at least one of a light emitting device in said light transmitting unit and a light receiving device in said light receiving unit is arranged on a surface of said waveguide, or in said waveguide.

5           11. The optical waveguide apparatus according to claim 10, further comprising an optical-path converting structure for converting at least one light beam emitted from said light emitting device into at least one light beam propagating in at least one predetermined direction, said optical-path converting structure being arranged in a portion of said waveguide below  
10   said light emitting device.

          12. The optical waveguide apparatus according to claim 11, wherein said optical-path converting structure has a spherical, hemispherical, conical, wedge-shaped, or polygonal pyramid-shaped structure.

15           13. The optical waveguide apparatus according to claim 12, wherein said light emitting device is a single VCSEL, or an arrayed-type VCSEL, said VCSEL being arranged such that light from said VCSEL can be coupled to a slant face or slant faces of said optical-path converting  
20   structure.

          14. The optical waveguide apparatus according to claim 10, wherein said light emitting device is a semiconductor laser having a ring resonator.

25           15. An opto-electronic hybrid circuit board for combining transmission of an optical signal and transmission of an electrical signal in a hybrid manner, said apparatus comprising:

an optical waveguide apparatus, said optical waveguide apparatus including a waveguide capable of propagating light in two-dimensional directions, a light transmitting unit for transmitting light through said waveguide, a light receiving unit for receiving light transmitted through  
5 said waveguide, and relaying means for relaying light transmitted from said light transmitting unit and propagating in said waveguide at a place between said light transmitting unit and said light receiving unit to transmit the relayed light to said light receiving unit; and

an electronic circuit layer, said electronic circuit layer being  
10 electrically connected to said optical waveguide apparatus;

wherein part or all of signals in said electronic circuit layer is distributed by transmission and reception of the optical signal using said optical waveguide apparatus to operate electronic equipment.

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## ABSTRACT OF THE DISCLOSURE

An optical waveguide apparatus includes a two-dimensional optical waveguide, a light transmitting unit for transmitting light through the optical waveguide, a light receiving unit for receiving light transmitted through the optical waveguide, and a relaying unit for relaying light  
5 transmitted through the waveguide from the light transmitting unit at a place between the light transmitting unit and the light receiving unit to transmit the relayed light to the light receiving unit. Arrangement flexibility of a light emitting device for converting an electrical signal into an optical signal and a light receiving device for converting an optical  
10 signal into an electrical signal is large, and an optical transmission can be effectively performed.